

**UNIT TERMINAL OBJECTIVE**

- 4-6     At the completion of this unit, the paramedic student will be able to integrate pathophysiological principles and the assessment findings to formulate a field impression and implement a treatment plan for the patient with a suspected spinal injury.

**COGNITIVE OBJECTIVES**

At the completion of this unit, the paramedic student will be able to:

- 4-6.1    Describe the incidence, morbidity, and mortality of spinal injuries in the trauma patient. (C-1)
- 4-6.2    Describe the anatomy and physiology of structures related to spinal injuries. (C-1)
  - a.      Cervical
  - b.      Thoracic
  - c.      Lumbar
  - d.      Sacrum
  - e.      Coccyx
  - f.      Head
  - g.      Brain
  - h.      Spinal cord
  - i.      Nerve tract(s)
  - j.      Dermatomes
- 4-6.3    Predict spinal injuries based on mechanism of injury. (C-2)
- 4-6.4    Describe the pathophysiology of spinal injuries. (C-1)
- 4-6.5    Explain traumatic and non-traumatic spinal injuries. (C-1)
- 4-6.6    Describe the assessment findings associated with spinal injuries. (C-1)
- 4-6.7    Describe the management of spinal injuries. (C-1)
- 4-6.8    Identify the need for rapid intervention and transport of the patient with spinal injuries. (C-1)
- 4-6.9    Integrate the pathophysiological principles to the assessment of a patient with a spinal injury. (C-3)
- 4-6.10   Differentiate between spinal injuries based on the assessment and history. (C-3)
- 4-6.11   Formulate a field impression based on the assessment findings. (C-3)
- 4-6.12   Develop a patient management plan based on the field impression. (C-3)
- 4-6.13   Describe the pathophysiology of traumatic spinal injury related to: (C-1)
  - a.      Spinal shock
  - b.      Spinal neurogenic shock
  - c.      Quadriplegia/ paraplegia
  - d.      Incomplete cord injury/ cord syndromes:
    - 1.      Central cord syndrome
    - 2.      Anterior cord syndrome
    - 3.      Brown-Sequard syndrome
- 4-6.14   Describe the assessment findings associated with traumatic spinal injuries. (C-1)
- 4-6.15   Describe the management of traumatic spinal injuries. (C-1)
- 4-6.16   Integrate pathophysiological principles to the assessment of a patient with a traumatic spinal injury. (C-3)
- 4-6.17   Differentiate between traumatic and non-traumatic spinal injuries based on the assessment and history. (C-3)
- 4-6.18   Formulate a field impression for traumatic spinal injury

- based on the assessment findings. (C-3)
- 4-6.19 Develop a patient management plan for traumatic spinal injury based on the field impression. (C-3)
- 4-6.20 Describe the pathophysiology of non-traumatic spinal injury, including: (C-1)
- a. Low back pain
  - b. Herniated intervertebral disk
  - c. Spinal cord tumors
- 4-6.21 Describe the assessment findings associated with non-traumatic spinal injuries. (C-1)
- 4-6.22 Describe the management of non-traumatic spinal injuries. (C-1)
- 4-6.23 Integrate pathophysiological principles to the assessment of a patient with non-traumatic spinal injury. (C-3)
- 4-6.24 Differentiate between traumatic and non-traumatic spinal injuries based on the assessment and history. (C-3)
- 4-6.25 Formulate a field impression for non-traumatic spinal injury based on the assessment findings. (C-3)
- 4-6.26 Develop a patient management plan for non-traumatic spinal injury based on the field impression. (C-3)

#### **AFFECTIVE OBJECTIVES**

At the completion of this unit, the paramedic student will be able to:

- 4-6.27 Advocate the use of a thorough assessment when determining the proper management modality for spine injuries. (A-3)
- 4-6.28 Value the implications of failing to properly immobilize a spine injured patient. (A-2)

#### **PSYCHOMOTOR OBJECTIVES**

At the completion of this unit, the paramedic student will be able to:

- 4-6.29 Demonstrate a clinical assessment to determine the proper management modality for a patient with a suspected traumatic spinal injury. (P-1)
- 4-6.30 Demonstrate a clinical assessment to determine the proper management modality for a patient with a suspected non-traumatic spinal injury. (P-1)
- 4-6.31 Demonstrate immobilization of the urgent and non-urgent patient with assessment findings of spinal injury from the following presentations: (P-1)
1. Supine
  2. Prone

- 3. Semi-prone
- 4. Sitting
- 5. Standing
- 4-6.32 Demonstrate documentation of suspected spinal cord injury to include: (P-1)
  - a. General area of spinal cord involved
  - b. Sensation
  - 3. Dermatomes
  - 4. Motor function
  - 5. Area(s) of weakness
- 4-6.33 Demonstrate preferred methods for stabilization of a helmet from a potentially spine injured patient. (P-1)
- 4-6.34 Demonstrate helmet removal techniques. (P-1)
- 4-6.35 Demonstrate alternative methods for stabilization of a helmet from a potentially spine injured patient. (P-1)
- 4-6.36 Demonstrate documentation of assessment before spinal immobilization. (P-1)
- 4-6.37 Demonstrate documentation of assessment during spinal immobilization. (P-1)
- 4-6.38 Demonstrate documentation of assessment after spinal immobilization. (P-1)

## **DECLARATIVE**

- I. Introduction
  - A. Spinal cord injury (SCI) impacts
    - 1. Human physiology
    - 2. Lifestyle
    - 3. Financial
    - 4. 1.25 million to care for a single victim with permanent SCI (overall life span)
- II. Incidences
  - A. 15,000 - 20,000 SCI per year
  - B. Higher in men between ages 16 - 30 years
  - C. Common causes
    - 1. Motor vehicle crashes - 2.1 million per year (48%)
    - 2. Falls (21%)
    - 3. Penetrating injuries (15%)
    - 4. Sports injuries (14%)
- III. Morbidity and mortality
  - A. 40% of trauma patients with neurological deficit will have temporary or permanent SCI
  - B. 25% of SCI may be caused by improper handling
  - C. Education in proper handling and transportation can decrease SCI
- IV. Traditional spinal assessments/ criteria
  - A. Based upon mechanism of injury (MOI)
  - B. Past emphasis for spinal immobilization considerations
    - 1. Unconscious accident victims
    - 2. Conscious accident victims checked for SCI prior to movement
    - 3. Any patient with a "motion" injury
  - C. Lack of clear clinical guidelines or specific criteria to evaluate for SCI
  - D. Signs which may indicate SCI
    - 1. Pain
    - 2. Tenderness
    - 3. Painful movement
    - 4. Deformity
    - 5. Cuts/ bruises (over spinal area)
    - 6. Paralysis
    - 7. Paresthesias

- 8. Paresis (weakness)
  - 9. Shock
  - 10. Priapism
  - E. Not always practical to immobilize every "motion" injury
  - F. Most suspected injuries were moved to a normal anatomical position
    - 1. Lying flat on a spine board
    - 2. No exclusion criteria used for moving patients to an anatomical position
  - G. Need to have clear criteria to assess for the presence of SCI
- V. General spinal anatomy and physiology review
- A. Spinal column
    - 1. Long bone
    - 2. 33 vertebrae
    - 3. Head balances at top of spine
    - 4. Spine supported by pelvis
    - 5. Ligaments and muscles connect head to pelvis
      - a. Anterior longitudinal ligament
        - (1) Runs on anterior portion of the body
        - (2) Major source of stability
        - (3) Protects against hyperextension
      - b. Posterior longitudinal ligament
        - (1) Runs along posterior body within the vertebral canal
        - (2) Prevents hyperflexion
        - (3) Can be a major source of injury
      - c. Other ligaments
        - (1) Cruciform ligament
        - (2) Accessory atlantoaxial ligament
        - (3) Add to strength, stability, and articulation
    - 6. Injury to ligaments may cause excess movement of vertebrae
  - B. Cervical spine
    - 1. 7 vertebrae
    - 2. Supports head (16 - 25 lbs)
    - 3. Considered "joint above" in splinting
    - 4. Very flexible
    - 5. C1 (atlas)
    - 6. C2 (axis)
  - C. Thoracic spine
    - 1. 12 vertebrae

- 2. Ribs connected
- 3. Provides rigid framework of thorax
- D. Lumbar spine
  - 1. 5 vertebrae
  - 2. Largest vertebral body
  - 3. Flexible
  - 4. Carries most of body weight
  - 5. Torso balances on sacrum
- E. Sacrum
  - 1. 5 fused vertebrae
  - 2. Common to spine and pelvis
  - 3. Forms "joint below" with pelvis for splinting
- F. Coccyx
  - 1. 4 fused vertebrae
  - 2. Tailbone
- G. Vertebral structure
  - 1. Body
    - a. Constructed of cancellous bone
    - b. Posterior portion forms part of the vertebral foramen
    - c. Increase in size when moving from cervical to sacral region for support of the trunk
- H. Vertebral foramen
  - 1. When all vertebrae are in place forms opening for spinal cord (vertebral canal)
  - 2. Formed by
    - a. Posterior portion of vertebral body
    - b. Pedicles
      - (1) Projecting posteriorly from vertebral body
    - c. Laminae
      - (1) Arise from pedicles and fuse into spinous process
      - (2) Failure of the laminae to unite during fetal development causes spina bifida
        - (a) Most commonly in the lumbosacral region
- I. Transverse process
  - 1. Runs from between the pedicles and laminae in most vertebrae
  - 2. Projects laterally and posteriorly
  - 3. Attachment site for various muscles and ligaments
- J. Spinous process
  - 1. Posterior aspect

- 2. Formed by the laminae
- 3. Attachment site for muscles and ligaments
- K. Intervertebral foramen
  - 1. Formed by the lower surfaces of the vertebrae
  - 2. Creates a “notch” for spinal nerves
    - a. Allows nerves to connect to the spinal cord
- L. Intervertebral disk
  - 1. Mass of fibrocartilage separating each vertebrae
  - 2. Connecting together by ligaments
  - 3. Acts as a shock absorber
    - a. Reducing bone wear
    - b. Compression protection
- M. Brain and spinal cord (central nervous system)
  - 1. Brain
    - a. Largest and most complex portion of the nervous system
    - b. Continuous with spinal cord
    - c. Responsible for all sensory and motor functions
  - 2. Spinal cord
    - a. Located within the vertebral canal
      - (1) Begins at foramen magnum
      - (2) Ending near L-2
    - b. Dural sheath
      - (1) Sheathed, tube-like sac
      - (2) Filled with cerebrospinal fluid (CSF)
  - 3. Blood supplied by
    - a. Vertebral arteries
    - b. Spinal arteries
  - 4. Gray matter
    - a. Core pattern in cord resembling butterfly with outspread wings
    - b. Most neurons in gray matter are interneurons
  - 5. White matter
    - a. Anatomical spinal tracts
      - (1) Longitudinal bundles of myelinated nerve fibers
  - 6. Ascending nerve tracts
    - a. Carries impulses from body parts and sensory information to the brain
    - b. Fasciculus gracilis and cuneatus
      - (1) Part of the posterior funiculi of cord
      - (2) Conduct sensory impulse from skin, muscle tendons, and joints to the brain for

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- interpretation as sensations of touch, pressure, and body movement
      - (3) Cross over at the medulla oblongata from one side to the other, therefore impulses originating from the left side ascend to the right side of the brain and vice versa
    - c. Spinothalamic tracts
      - (1) Lateral and anterior tracts located in the lateral and anterior funiculi
      - (2) Lateral tracts conduct impulses of pain and temperature to the brain
      - (3) Impulses cross over in the spinal cord
      - (4) Anterior tracts carry impulses of touch and pressure to the brain
      - (5) Spinocerebellar tracts (anterior and posterior) are found near the lateral funiculi and function to coordinate impulses necessary for muscular movements by carrying impulses from muscles in legs and trunk to cerebellum
  - 7. Descending nerve tracts
    - a. Carries motor impulses from the brain to the body
    - b. Corticospinal tracts (pyramidal tracts)
      - (1) Lateral tract crosses over at medulla oblongata
        - (a) Anterior tract descend uncrossed
        - (b) Functions to conduct motor impulses from the brain to spinal nerves and out to the body for voluntary movements
      - (2) Reticulospinal tracts
        - (a) Lateral, anterior, and medial tracts
        - (b) Mix of crossed and uncrossed fibers
          - i) Some lateral fibers cross over while others do not
          - ii) Anterior and medial tracts remain uncrossed
        - (c) Motor impulses originate in the brain to control muscle tone and sweat gland activity
      - (3) Rubrospinal tracts
        - (a) Fibers cross over in brain at pass through the lateral funiculi
        - (b) Motor impulses from the brain



controlling muscle coordination and control of posture

8. Spinal nerves
  - a. 31 pairs
    - (1) Originates from the spinal cord
  - b. Mixed nerves
    - (1) Carries both sensation and motor function
    - (2) Provides two-way communication between spinal cord and body parts
  - c. Named according to level of spine from which they arise
    - (1) Cervical 1-8
    - (2) Thoracic 1-12
    - (3) Lumbar 1-5
    - (4) Sacral 1-5
    - (5) Coccygeal 1 set of nerves
  - d. Spinal nerve
    - (1) Emerges from the cord
    - (2) Two short branches or roots
    - (3) Dorsal root
      - (a) Carries sensory impulses to the cord
    - (4) Ventral root
      - (a) Carries motor impulses from the cord to the body
9. Motor and sensory dermatomes
  - a. Dermatome is the particular area in which the spinal nerves travels or controls
  - b. Mapped out by level of the spinal nerve
  - c. Useful for assessment for a specific level of SCI
  - d. Table for common nerve root and motor/ sensory correlation

<u>Nerve Root</u>	<u>Motor</u>	<u>Sensory</u>	
C-3,4	Trapezius (shoulder shrug)	Top of shoulder	Top o
C-3,4,5	Diaphragm	Top of shoulder	
C-5,6	Biceps (elbow flexion)		Thumb
C-7	Triceps (elbow extension)	Middle finger	
	wrist/ finger extension		
C-8/ T-1	Finger abduction/ adduction		

		Little finger
T-4	Nipple	
T-10	Umbilicus	
L-1,2	Hip flexion	
		Inguinal crease
L-3,4	Quadriceps	
		Medial thigh/ calf
L-5	Great toe/ foot dorsiflexion	
		Lateral calf
S-1	Knee flexion	Lateral foot
S-1,2	Foot plantar flexion	
S-2,3,4	Anal sphincter tone	
		Perianal

## VI. General assessment of spinal injuries

### A. Determine mechanism of injury/ nature or injury

#### 1. Positive MOI

- a. Always requires full spinal immobilization
  - (1) High speed motor vehicle crash(es)
  - (2) Falls greater than three times patient's height
  - (3) Violent situations occurring near the spine
    - (a) Stabbings
    - (b) Gun shots
    - (c) Others
  - (4) Sports injuries
  - (5) Other high impact situations
- b. Some medical directors may allow field personnel to not immobilize patients with MOI but without signs and/ or symptoms of a SCI
  - (1) Based on assessment
    - (a) Patient reliability
    - (b) No distracting injuries
    - (c) Lack of signs or symptoms

#### 2. Negative MOI

- a. Forces or impact involved does not suggest a potential spinal injury
- b. Does not require spinal immobilization

- (1) Examples
  - (a) Dropping a rock on foot
  - (b) Twisted ankle while running
  - (c) Isolated soft tissue injury
- 3. Uncertain MOI
  - a. Unclear or uncertainty regarding the impact or forces
  - b. Clinical criteria used for a basis of whether to employ spinal immobilization
    - (1) Examples
      - (a) Person trips over garden hose, falling to the ground and hitting their head
      - (b) Fall from 2-4 feet
      - (c) Low speed motor vehicle crash (fender bender)
- 4. Clinical criteria versus mechanism of injury
  - a. Initial management
    - (1) Based solely upon MOI
  - b. Positive MOI
    - (1) Spine immobilization
  - c. Negative MOI
    - (1) Without signs or symptoms
      - (a) No spine immobilization
  - d. Uncertain MOI
    - (1) Need for further clinical assessment and evaluation
  - e. In some non-traumatic spinal conditions immobilization may be necessary/ indicated
  - f. Altered LOC or unconsciousness requires spine stabilization

#### VII. Assessment of uncertain MOIs

- A. Specific clinical criteria
  - 1. Necessary to assess when electing not to immobilize a trauma patient
  - 2. Begins with patient reliability
    - a. Continually reassessed during specific exam
  - 3. If specific criteria cannot be clearly satisfied; complete spine immobilization undertaken
  - 4. Positive MOI always equals spine immobilization
    - a. This specific assessment may still be used to determine level of injury
- B. Specific criteria

1. Prevent motion of the spine by assistant maintaining stabilization throughout the exam
2. Reliable patients/ exam
  - a. In order for assessments of pain, tenderness, motor, and sensory function to be accurate the patient must be reliable
  - b. Patient must be
    - (1) Calm
    - (2) Cooperative
    - (3) Sober
      - (a) Alcohol
      - (b) Drugs
    - (4) Alert and oriented
  - c. Unreliable patient defined
    - (1) Acute stress reaction
      - (a) Sudden stress of any type
    - (2) Brain injury
      - (a) Any temporary change in consciousness or altered level of consciousness
      - (b) Uncooperative or belligerent behavior
    - (3) Intoxication
    - (4) Abnormal mental status
    - (5) Distracting injuries
    - (6) Communication problems
  - d. Unreliable indicators present
    - (1) Full spinal immobilization indicated
3. Assess for spinal pain
  - a. Patient is asked about
    - (1) Any related spinal pain
    - (2) Signs
    - (3) Symptoms
  - b. May be poorly localized
  - c. Might not feel directly over the spinous process
  - d. Pain with active movement of head and neck
    - (1) Patient is asked to slowly move their head and neck
    - (2) If any pain occurs
      - i) Full immobilization is indicated
      - ii) May not be able to splint in normal anatomical position
4. Assess for spine tenderness
  - a. Palpate over each of the spinous processes of the vertebra

- b. Begin at the neck and work towards the pelvis
- c. May be beneficial to palpate back up from the pelvis to the neck
- 5. Upper extremity neurological function assessment
  - a. Motor function
    - (1) Finger abduction/ adduction
      - (a) Test interosseous muscle function controlled by T-1 nerve roots
      - (b) Have patient spread fingers of both hands and keep them apart while you squeeze the 2nd and 4th fingers
      - (c) Normal resistance should be spring-like and equal on both sides
    - (2) Finger/ hand extension
      - (a) Test the extensors of the hand and fingers controlled by C-7 nerve roots
      - (b) Have patient hold wrist or fingers straight out and keep them out while you press down on their fingers
      - (c) Support the arm at the wrist to avoid testing arm function and other nerve roots
      - (d) Normal resistance should be felt to moderate pressure
      - (e) Both right and left sides should be checked
      - (f) Can still check if isolated, e.g., finger fracture, push on hand only not fingers; if wrist injury support MP joints and push on fingers only
  - b. Sensory function
    - (1) Pain sensation
      - (a) Abnormal sensation - ask patient about weakness, numbness, paresthesia, or radicular pain
      - (b) Pain or pinprick controlled by spinothalamic tracts
      - (c) Need to separate from light touch (remember light touch carried by more than one tract)
      - (d) Use end of pen or broken Q-tip (avoid sharp objects which may damage or cause bleeding)

- (e) Have patient close eyes and hold out hands; ask the patient to compare between sharp and dull pain
  - (f) Compare on both sides of the body; equal on both sides
- 6. Lower extremity neurological function assessment
  - a. Motor function
    - (1) Foot plantar flexion
      - (a) Tests plantar flexors of the foot controlled by S-1,2 nerve root
      - (b) Place your hands at the sole of each foot and have the patient push against your hands
      - (c) Both sides should feel equal and strong
    - (2) Foot/ great toe dorsiflexion
      - (a) Tests the dorsal flexors of the foot and great toe controlled by the L-5 nerve roots
      - (b) Hold foot with fingers on toes and instruct patient to pull foot back or towards their nose
  - b. Sensory function
    - (1) Pain sensation
      - (a) Abnormal sensation - ask patient about weakness, numbness, paresthesia, or radicular pain
      - (b) Pain or pinprick controlled by spinothalamic tracts
      - (c) Need to separate from light touch (remember light touch carried by more than one tract)
      - (d) Use end of pen or broken Q-tip (avoid sharp objects which may damage or cause bleeding)
      - (e) Have patient close eyes and hold out hands; ask the patient to compare between sharp and dull pain
      - (f) Compare on both sides of the body; equal on both sides
- 7. General motor function assessment
  - a. Tests nerve roots at both cervical and lumbar/sacral spine levels
  - b. Check two sets of nerve roots at each level as

- well as left and right sides
- c. Able to determine most clinical patterns of SCI
- d. Motor exams can to be completed even if local injury exists
  - (1) If exam cannot be completed due to local injury entire exam is unreliable
  - (a) Spinal immobilization indicated
- 8. Sensory function assessment
  - a. Test (exam) sensory
    - (1) At cervical and lumbar/ sacral spine levels
    - (a) On both right and left sides
  - b. Sensory exam will detect clinical patterns of SCI
  - c. Any signs or symptoms of abnormal sensation
    - (1) Spinal immobilization indicated
- VIII. General management of spinal injuries
  - A. Principles of spinal immobilization
    - 1. Primary goal is to prevent further injury
    - 2. Treat spine as a long bone with a joint at either end (head and pelvis)
    - 3. 15% of secondary spinal injuries are preventable with proper immobilization
    - 4. Always use "complete" spine immobilization
      - a. Impossible to isolate and splint specific injury site
    - 5. Spine stabilization begins in the initial assessment
      - a. Continues until the spine is completely immobilized on a long backboard
    - 6. Head and neck should be placed in a neutral, in-line position unless contraindicated
      - a. Neutral positioning allows for the most space for the cord
        - (1) Reducing cord hypoxia
        - (2) Reducing excess pressure
      - b. Most stable position for the spinal column
        - (1) Reduces instability
  - B. Spinal stabilization/ immobilization
    - 1. Systematic approach
      - a. Cervical immobilization
        - (1) Manual
        - (2) Rigid collar
      - b. Interim immobilization device
        - (1) When indicated (vest type mobilization)

- device, short backboard)
- (2) Movement of a stable patient from a seated position to a long backboard
- c. Long backboard
- d. Full body vacuum splints
- e. Padding (body shims)
  - (1) Use to maintain anatomical position
  - (2) Limits movement of patient
  - (3) Fill all voids
  - (4) Pillows
  - (5) Towels
  - (6) Blankets
- f. Straps
  - (1) Sufficient to immobilize to the long backboard
    - (a) Upper torso
    - (b) Pelvis
    - (c) Legs
    - (d) Feet
- g. Cervical immobilization device
  - (1) Commercial
  - (2) Tape
  - (3) Blanket roll
  - (4) Pillows
- h. Helmeted patients
  - (1) Special assessment needs for patients wearing helmets
    - (a) Airway and breathing
    - (b) Fit of helmet and movement within the helmet
    - (c) Ability to gain access to airway and breathing
  - (2) Indications for leaving the helmet in place
    - (a) Good fit with little or no head movement within helmet
    - (b) No impending airway or breathing problems
    - (c) Removal may cause further injury
    - (d) Proper spinal immobilization could be performed with helmet in place
    - (e) No interference with ability to assess and reassess airway
  - (3) Indications for helmet removal



- (a) Inability to assess or reassess airway and breathing
- (b) Restriction of adequate management of the airway or breathing
- (c) Improperly fitted helmet with excessive head movement within helmet
- (d) Proper spinal immobilization cannot be performed with helmet in place
- (e) Cardiac arrest
- (4) Types of helmets
  - (a) Sports
    - i) Typically worn anteriorly
    - ii) Easier access to airway
  - (b) Motorcycle
    - i) Full face
    - ii) Shield
  - (c) Other
- (5) General guidelines for helmet removal
  - (a) Type of helmet worn by the patient will influence the technique used for removal
  - (b) First person stabilizes the head and neck by placing hands on the side of the helmet with fingers extended under lower face piece (or chin)
  - (c) Second person removes face shield (if present) and/or eye wear before helmet removal
  - (d) Second person removes chin strap
  - (e) Second person places one hand on mandible and the other posteriorly on the occipital region (posterior caudal edge of helmet)
  - (f) First person then begins to remove the helmet by pulling the sides apart, sliding the helmet a short distance (approximately 4-6 cm) and then stops
  - (g) First person again stabilizes the head and neck with hands holding the sides of the helmet
  - (h) Second person slides hands cephalad (towards the top of the head) until the head is stabilized between the posterior or hand (now cupped under the inferior

occiput) and the anterior hand now inserted under the lower part of the face piece - if the helmet has one (thumb and first finger now holding the unmovable maxilla)

- (i) First person again pulls the sides of the helmet apart and continues to withdraw the helmet - rotating the helmet as necessary so any lower face piece clears the nose and then an opposite movement so the posterior caudal end of the helmet is removed following the posterior curvature of the patient's head
- (j) Once the helmet has been completely removed, the first person regains stabilization of the patient's head and neck by placing their hands along the sides of the patient's head with their fingers spread apart for maximum support - second person can now let go of the anterior/posterior support
- (k) Second person can now continue with the assessment, measurement and application of a cervical collar, further immobilization and care of the patient

C. Use of steroids for traumatic spine injuries

## IX. Traumatic injuries

### A. Causes

- 1. Direct trauma
- 2. Excessive movement
  - a. Acceleration
  - b. Deceleration
  - c. Deformation
- 3. Directions of force
  - a. Flexion or hyperflexion
    - (1) Excessive forward motion of the head

- (2) May cause
  - (a) Wedge fracture of anterior vertebrae
  - (b) Stretching or rupturing of interspinous ligaments
  - (c) Compressed injury to spinal cord
  - (d) Disruption of disk with forward dislocation of vertebrae
  - (e) Fracture of pedicle and disruption of interspinous ligament
- (3) Cervical area common injury site
- b. Extension or hyperextension
  - (1) Excessive backward movement of the head
  - (2) May cause
    - (a) Disruption of the intervertebral disks
    - (b) Osteophytes and compression of the spinal cord
    - (c) Compression of the interspinous ligament
    - (d) Fracture
  - (3) Cervical area common injury site
- c. Rotational
  - (1) Usually from acceleration forces
  - (2) May cause
    - (a) Flexion-rotation dislocation
    - (b) Fracture or dislocation of vertebrae
    - (c) Rupture of supporting ligaments
  - (3) Cervical area common injury site
- d. Lateral bending
  - (1) Often caused by direct blow to the side of the body
  - (2) May cause
    - (a) May cause lateral compression of the vertebral body
    - (b) may cause lateral displacement of the vertebra
    - (c) May stretch the ligaments
- e. Vertical compression
  - (1) Force applied along spinal axis
    - (a) Usually from top of cranium to vertebral body from sudden deceleration, e.g., diving accident
  - (2) May cause
    - (a) Compression fracture without SCI
    - (b) Crushed vertebral body with SCI

- (3) Most common injury site(s)
      - (a) T-12 to L-2
  - f. Distraction
    - (1) Force applied to spinal axis to distract or pull apart, e.g., hanging injury
    - (2) May cause
      - (a) Stretching of spinal cord
      - (b) Stretching of supporting ligaments
    - (3) Cervical area most common injury site
  - 4. Can have "spinal column injury" (bony injury) with or without "SCI"
  - 5. Can have "SCI" with or without "spinal injury"
- B. Types of spinal cord injuries (SCI)
  - 1. Primary injury
    - a. Occurs at time of impact/ injury
    - b. Causes
      - (1) Cord compression
      - (2) Direct cord injury
        - (a) Sharp or unstable bony structures
      - (3) Interruption in the cord's blood supply
  - 2. Secondary injury
    - a. Occurs after initial injury
    - b. Causes
      - (1) Swelling
      - (2) Ischemia
      - (3) Movement of bony fragments
  - 3. Cord concussion
    - a. Results from temporary disruption of cord-mediated functions
  - 4. Cord contusion
    - a. Bruising of the cord's tissues
    - b. Causes
      - (1) Swelling
    - c. Temporary loss of cord-mediated function
  - 5. Cord compression
    - a. Pressure on the cord
    - b. Causes tissue ischemia
    - c. Must be decompressed to avoid permanent loss/ damage to cord
  - 6. Laceration
    - a. Tearing of the cord tissue
    - b. May be reversed if only slight damage
    - c. May result in permanent loss if spinal tracts are

- disrupted
- 7. Hemorrhage
  - a. Bleeding into the cord's tissue
  - b. Caused by damage to blood vessels
    - (1) Injury related to amount of hemorrhage
  - c. Damage or obstruction to spinal blood supply results in local ischemia
- 8. Cord transection
  - a. Complete
    - (1) All tracts of the spinal cord completely disrupted
    - (2) Cord-mediated functions below transection are permanently lost
    - (3) Accurately determined after at least 24 hours post-injury
    - (4) Results in
      - (a) Quadriplegia
        - i) Injury at the cervical level
        - ii) Loss of all function below injury site
      - (b) Paraplegia
        - i) Injury at the thoracic or lumbar level
        - ii) Loss of lower trunk only
  - b. Incomplete
    - (1) Some tracts of the spinal cord remain intact
    - (2) Some cord-mediated functions intact
    - (3) Has potential for recovery
      - (a) Function may only be temporarily lost
    - (4) Types
      - (a) Anterior cord syndrome
        - i) Caused by bony fragments or pressure on spinal arteries
        - ii) Involves loss of motor function and sensation to pain, temperature and light touch
        - iii) Sensation to light touch, motion, position, and vibration are spared
      - (b) Central cord syndrome
        - i) Usually occurs with a hyperextension of the cervical region
        - ii) Weakness or paresthesias in upper

- extremities but normal strength in lower extremities
- iii) May have varying degrees of bladder dysfunction
- (c) Brown-Sequard syndrome
  - i) Caused by penetrating injury
  - ii) Hemisection of the cord
  - iii) Involves only one side of the cord
  - iv) Complete damage to all spinal tract on involved side
  - v) Isolated loss of all types of functions, e.g., motor pain, temperature, motion, position, etc.
  - vi) Pain and temperature lost on opposite side of the body
  - vii) Motor function, motion, position, vibration, and light touch on the same side as injury
- 9. Chemical and metabolic changes due to SCI
- 10. Spinal shock
  - a. Refers to temporary loss of all types of spinal cord function distal to injury
  - b. Flaccid paralysis distal to injury site
  - c. Loss of autonomic function
    - (1) Hypotension
    - (2) Vasodilatation
    - (3) Loss of bladder and bowel control
    - (4) Priapism
    - (5) Loss of thermoregulation
  - d. Does not always involve permanent primary injury
    - (1) Usually will resolve in a period of hours to weeks
    - (2) Manage carefully to avoid secondary injury
- 11. Spinal neurogenic shock
  - a. Also called spinal vascular shock
  - b. Temporary loss of the autonomic function of the cord at the level of injury which
  - c. Presentation includes
    - (1) Loss of sympathetic tone
    - (2) Relative hypotension
      - (a) Systolic pressure 80 - 100 mmHg
    - (3) Skin pink, warm and dry
      - (a) Due to cutaneous vasodilation

- (4) Relative bradycardia
  - d. Rare in occurrence
  - e. Shock presentation is usually the result of hidden volume loss
    - (1) Chest injuries
    - (2) Abdominal injuries
    - (3) Other violent injuries
  - f. Treatment
    - (1) Focus primarily on volume replacement
12. Autonomic hyperreflexia syndrome
- a. Associated after resolution of spinal shock
    - (1) Chronic SCI patients
  - b. Massive, uncompensated cardiovascular response
    - (1) Stimulation of the sympathetic nervous system
  - c. Life-threatening condition usually seen with injuries at T-6 or above
  - d. Characteristics are
    - (1) Paroxysmal hypertension (up to 300 mmHg systolic)
    - (2) Headache (pounding)
    - (3) Blurred vision
    - (4) Sweating
      - (a) Above level of injury with flushing of the skin
    - (5) Increased nasal congestion
    - (6) Nausea
    - (7) Bradycardia
    - (8) Associate distended bladder or rectum
  - e. Stimulation of the sensory receptors below the level of the cord injury
    - (1) Autonomic nervous system reflexively responds with arteriolar spasm
      - (a) Increases blood pressure
    - (2) Cerebral, carotid, and aorta baroreceptors sense hypertension
      - (a) Stimulates the parasympathetic nervous system
      - (b) Heart rate decreases
      - (c) Peripheral and visceral vessels unable to dilate due to cord damage
    - (3) May be treated with an antihypertensive medication

- X. Non-traumatic spinal conditions
  - A. Low back pain (LBP)
    - 1. Affected area
      - a. Between lower rib cage and gluteal muscles
      - b. May radiate to thighs
    - 2. 1% of acute low back pain is sciatica
      - a. Usual cause is in the lumbar nerve root
      - b. Pain accompanied by motor and sensory deficits, e.g., weakness
    - 3. 60% - 90% of population experience some form of low back pain
      - a. Affects men and women equally
      - b. Women over 60 years old report low back pain symptoms more often
    - 4. Most cases of LBP are idiopathic
      - a. Precise diagnosis difficult
    - 5. Causes
      - a. Tension from tumors
      - b. Disk prolapsed
      - c. Bursitis
      - d. Synovitis
      - e. Rising venous pressure
      - f. Tissue pressure due to degenerative joint disease
      - g. Abnormal bone pressure
      - h. Problems with spinal mobility
      - i. Inflammation caused by infection
        - (1) Osteomyelitis
      - j. Fractures
      - k. Ligament strains
    - 6. Risk factors
      - a. Occupations requiring repetitious lifting
      - b. Exposure to vibrations from vehicles or industrial machinery
      - c. Osteoporosis
    - 7. Anatomical considerations
      - a. Pain from innervated structures
        - (1) Varies from person-to-person
      - b. Disk has no specific innervation
        - (1) Compresses cord if herniated
      - c. Source of pain in L-3,4,5, and S-1 may be interspinous bursae
      - d. Anterior and posterior longitudinal ligaments, and other ligaments are richly



- supplied with pain receptors
- e. Muscles of spine vulnerable to sprains/ strains
- 8. Degenerative disk disease
  - a. Common for patients over 50 years of age
  - b. Causes
    - (1) Degeneration of disk
      - (a) Biomechanical alterations of intervertebral disk
  - c. Narrowing of the disk
    - (1) Results in variable segment stability
- 9. Spondylolysis
  - a. Structural defect of spine
    - (1) Involves the lamina or vertebral arch
  - b. Usually occurs between superior and inferior articulating facets
  - c. Heredity a significant factor
  - d. Rotational fractures common at affected site
- 10. Herniated intervertebral disk
  - a. Also called herniated nucleus pulposus
  - b. Tear in the posterior rim of capsule enclosing the gelatinous center of the disk
  - c. Causes
    - (1) Trauma
    - (2) Degenerative disk disease
    - (3) Improper lifting
      - (a) Most common cause
  - d. Men ages 30 - 50 years are more prone than women
  - e. Commonly affects L-5, S-1 and L-4, L-5 disks
  - f. May also occur in C-5, C-6, and C-7
- 11. Spinal cord tumors
  - a. Causes
    - (1) Compression of the cord
    - (2) Degenerative changes in the bone/ joints
    - (3) Interrupted the blood supply
  - b. Manifestations are dependent upon
    - (1) Tumor type and location

- XI. Assessment and management of non-traumatic spinal conditions
- A. Assessment - based mainly upon the patient's chief complaint and physical exam
    - 1. Low back pain
      - a. Based mainly upon history and chief complaint
        - (1) Risk factors include

- (a) Occupations requiring repetitive lifting
      - (b) Exposure to vibrations from vehicles or industrial machinery
      - (c) Osteoporosis
    - b. Precise diagnosis difficult
      - (1) Based primarily on physical exam and other in-hospital testing
        - (a) CT scan
        - (b) Electromyelography
        - (c) MRI
        - (d) Others
  - 2. Herniated intervertebral disk
    - a. Tear in the posterior rim of capsule enclosing the gelatinous center of the disk
      - (1) Causes
        - (a) Trauma
        - (b) Degenerative disk disease
        - (c) Improper lifting
          - i) Most common cause
      - (2) Pain usually occurs with straining
        - (a) Coughing or sneezing
      - (3) May have limited range of motion in lumbar spine
      - (4) Tenderness upon palpation
      - (5) Alternations in sensation, pain, and temperature
      - (6) Due to nerve root pressure
      - (7) Cervical herniations may include
        - (a) Upper extremity pain or paresthesia
          - i) Increasing with neck motion
        - (b) Slight motor weakness may also occur in biceps and triceps
  - 3. Spinal cord tumors
    - a. Tumors of the spine which cause
      - (1) Compression of the cord
      - (2) Degenerative changes in the bone/ joints
      - (3) Interruption in the blood supply
    - b. Manifestations are dependent upon
      - (1) Tumor type
      - (2) Location
- B. Management
  - 1. Primarily palliative to decrease any pain or discomfort from movement

2. May elect to immobilize to aid in comfort
  - a. Long back board
  - b. Vacuum type stretcher
3. Full spinal immobilization is not required unless condition is a result of trauma

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